GB 1562929
MAR 1980

SPECIFICATION (11) 1 562 929

1 562 929

(21) Application No. 1718/76 (22) Filed 16 Jan. 1976 (19)

(23) Complete Specification filed 14 Jan. 1977

(44) Complete Specification published 19 March 1980

(51) INT. CL³ H01J 61/82

(52) Index at acceptance
H1D 12B13Y 12B1 12B2 12B47Y 12B4 12B8 12C 12G 35 5C3 5H 5P3 9A 9B 9C2 9FX 9FY 9H 9Y

(72) Inventors BRUCE ALLEN MOYS and CHARLES EDINGTON WILLIAMS

(54) IMPROVEMENTS IN OR RELATING TO HIGH PRESSURE ELECTRIC DISCHARGE LAMPS

(71) We, THE GENERAL ELECTRIC COMPANY LIMITED, of 1 Stanhope Gate, London W1A 1EH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to high pressure electric discharge lamps of the type (hereinafter referred to as the type specified) consisting of a single light source mounted within an outer envelope of light-transmissive vitreous material, the said light source being a tubular discharge envelope containing a filling of mercury and a small amount of rare gas for facilitating starting of the discharge, with or without one or more additives consisting of metals and/or metal halides which are vaporisable at the operating temperature of the lamp, and having mounted within the end regions of the discharge envelope a pair of electrodes between which an electric discharge passes in operation of the lamp, the electrodes being attached to conducting leads extending to the exterior of the discharge envelope, and the said outer envelope being fitted with a cap or caps designed to be inserted into a lampholder or lampholders and incorporating terminals to which the said leads are connected for connection of the electrodes to a source of electric current supply for operation of the lamp. The invention is more particularly concerned with lamps of this type which are intended to be operated with the longitudinal axis of the discharge envelope disposed horizontally. The term "high pressure", as used herein with reference to the lamps concerned, is to be understood to mean that the total vapour pressure developed within the discharge envelope in normal operation of the lamp is at least one atmosphere.

The outer envelope of a lamp of the type specified assists in maintaining the discharge envelope at a suitably high temperature when the lamp is in operation; in known lamps of this type, the outer envelope is usually of a somewhat elongated bulbous shape, and the discharge envelope is mounted in such a manner that the two envelopes are coaxial. However, difficulties arise in avoiding the development of undesirably large differences in temperature between different parts of the discharge envelope wall during operation: thus, in addition to the fact that the end regions of the discharge envelope, behind the portions of the electrodes on which the discharge terminates, are not heated by the discharge to the same extent as the central region of the envelope, the upper part of the envelope tends to become hotter than the lower part thereof, as a result of the buoyancy of the hotter part of the vaporised filling of the discharge envelope, and of the hotter part of the gas filling of the outer envelope when such filling is present. This buoyancy effect is particularly disadvantageous in the case of a lamp operated in the horizontal position as aforesaid, and in which the discharge is in the form of a constricted arc, since such buoyancy causes upward bowing of the arc, which may thus come into contact with, or approach closely to, the upper part of the discharge envelope wall, causing overheating of, and possibly damage to, the upper part of the wall, and producing a considerable temperature difference between the upper and lower parts of the discharge envelope wall. The overheating of the upper surface of the discharge envelope may also be augmented by convective flow of hot vapor or gas in the discharge envelope or in the outer envelope.

The occurrence of a marked temperature difference between the upper and lower parts of the discharge envelope wall is especially undesirable in the case of a lamp in which one or more metal halides of relatively low vapour pressure is or are present in the

discharge envelope filling, since such halides tend to condense in the coolest part of the envelope. Since the luminous efficacy of such a lamp increases with increasing vapour pressure of the metal halides within the discharge envelope, and the vapour pressure increases with increasing temperature of the condensate, it is desirable that the coolest part of the envelope, and hence the condensate, should be maintained at as high a temperature as possible, by achieving a more nearly uniform temperature distribution between different parts of the envelope. Furthermore, when condensation occurs on the lower part of the envelope wall of a horizontally disposed discharge envelope the condensed material will partially obscure light emission through that part of the wall, and may alter colour appearance by non-uniform spectral absorption.

It is an object of the present invention to provide improvements in the construction of a lamp of the type specified, designed for horizontal operation, whereby temperature differences produced between different parts of the discharge envelope during operation of the lamp can be reduced, so as to avoid the risk of thermal damage to the upper part of the discharge envelope wall and, where metal halides are present in the discharge envelope filling, to achieve relatively high vapour pressure in operation and hence high luminous efficacy, and possibly to prevent condensation of such halides occurring in a location in which the condensed material will obstruct light emission to an undesirable extent.

According to the invention, in a high pressure electric discharge lamp of the type specified, the outer envelope is of constant cross-section elongate cylindrical form and the discharge envelope is mounted within the outer envelope with its longitudinal axis parallel to the longitudinal axis of the outer envelope but displaced therefrom, the lamp in use being operated with both of the said axes disposed horizontally and with the said axis of the discharge envelope substantially vertically below (as hereinafter defined) the said axis of the outer envelope.

For operation of a lamp in accordance with the invention, the lamp is mounted in a lampholder or pair of lampholders in such a position that the discharge envelope is disposed with its longitudinal axis lying horizontally, and the lamp is so orientated that the said axis of the discharge envelope lies substantially vertically below the longitudinal axis of the outer envelope. The outer envelope may be provided with locating means for ensuring correct orientation of the lamp in the operating position.

In operation of a lamp of the type with which this invention is concerned, in which the outer envelope is evacuated, each part of the discharge envelope wall attains an equilibrium temperature at which the rate of absorption of heat from the discharge is balance by the rate of loss of heat by radiation, the net radiation loss being the difference between the heat radiated from that part of the discharge envelope wall to, and the heat radiation received by said part of the wall from, the surroundings which include the adjacent part of the outer envelope wall. In a horizontally operated lamp constructed in accordance with the invention, that is to say with the discharge envelope mounted relatively close to that part of the outer envelope wall which is lowermost when the lamp is in the operating position, the amount of radiation received in operation by the lower part of the discharge envelope wall from the relatively near, lower part of the outer envelope wall is greater than the amount of radiation received by the upper part of the discharge envelope wall from the more distant upper part of the outer envelope wall. Hence the equilibrium temperature of the lower part of the discharge envelope wall is raised, as a result of the proximity of the outer envelope wall, and conversely the equilibrium temperature of the upper part of the discharge envelope wall is reduced, in comparison with the corresponding equilibrium temperature in a similar lamp of the conventional construction in which the discharge envelope and the outer envelope are coaxial. If the outer envelope contains a gas filling, similar conditions prevail in respect of the outer envelope wall, and in addition it appears likely that, with the arrangement of the invention, relatively static gas will be trapped in the space between the lower parts of the walls of the discharge envelope and the outer envelope, so that convective flow of the gas in the outer envelope, which would result in cooling of the lower part of the discharge envelope wall, will be restricted.

Thus in operation of a lamp constructed in accordance with the invention, the difference between the temperatures attained respectively by the upper and lower parts of the discharge envelope wall is reduced, the temperature of the lower part of the wall in some cases being raised sufficiently to prevent the condensation thereon of any metal halides present; with optimum dimensioning of the lamp and positioning of the discharge envelope within the outer envelope these temperatures can be substantially equalised. The end regions of the discharg envelope may then be cooler than the central region of the envelope, so that if metal halides of low vapour pressure are present in the filling, condensation of these halides will tend to occur in these end regions: condensation of halides in the end regions of the discharge envelope is less objection-

able from the point of view of light obstruction than is the occurrence of condensation on the lower part of the wall of the central region of the envelope. Furthermore, whether condensation of metal halides takes place in the end regions of the discharge envelope or on the lower part of the wall of the central region, the temperature of the condensate will be raised as a result of the improvement in uniformity of temperature distribution throughout the envelope, and hence the vapour pressure of the halides within the envelope will be increased, with consequent beneficial effect on the luminous efficacy of the lamp.

In a preferred form of the lamp in accordance with the invention, the outer envelope is of circular cross-section, the external diameter of the discharge envelope is approximately one third of the internal diameter of the outer envelope, and the discharge envelope is suitably so positioned within the outer envelope that the distance between the most closely adjacent parts of the walls of the discharge envelope and the outer envelope, that is to say those parts of said walls which are lowermost when the lamp is in the correct horizontal operating position, is approximately one twelfth of the internal diameter of the outer envelope, but is not less than 3 millimetres. If the said distance were appreciably less than 3 millimetres, the part of the outer envelope closely adjacent to the discharge envelope would be liable to become overheated in operation and to soften or crack.

For obtaining the optimum operating conditions, the outer envelope is preferably so arranged that, when the lamp is in the operating position, the longitudinal axis of the discharge envelope lies precisely vertically below the horizontal axis of the outer envelope, however a slight displacement of the discharge envelope axis to one side of the vertical plane through the said outer envelope axis can be tolerated. It will be understood that the phrase "substantially vertically below", used above with reference to the position of the discharge envelope axis, allows for such displacement to an extent insufficient to have a significant effect on the relative operating temperatures of the various parts of the discharge envelope which are obtained with precise vertical positioning. Locating means for ensuring correct orientation of the lamp may conveniently be carried on, or included in the construction of, the cap or caps fitted over one end or both ends of the outer envelope, and are arranged to co-operate with suitable means provided in the lampholder or lampholders in which the lamp is mounted for use.

The lamp may be of the single ended type, that is to say the type in which the conducting leads to both electrodes are sealed through the same end of the outer envelope and connected to terminals incorporated on a single cap fitted over the said end of the envelope. Preferably, however, the lamp is of the double ended type, in which the lead to each electrode is sealed through the end of the outer envelope adjacent to that electrode, and each end of the outer envelope is fitted with a cap incorporating a terminal to which the lead sealed through that end is connected.

An outer envelope of the double ended form is advantageous since the caps employed can be of a type capable of ensuring specific location of the lamp in the correct horizontal operating position. For example, bipin caps of the type generally employed for tubular low pressure fluorescent discharge lamps are suitable: thus one pin on each cap constitutes a terminal to which the lead to the adjacent electrode is connected, and the pair of pins on each cap can be accurately aligned relative to one another, to the pair of pins on the other cap, and in relation to the position of the discharge envelope within the outer envelope, so as to ensure that when the two pairs of pins are inserted in correspondingly oriented co-operating lampholders the longitudinal axes of the discharge envelope and the outer envelope will lie in the same vertical plane. Hence, provided that the lamp is correctly oriented in the lampholders, with the discharge envelope in the lower part of the outer envelope, the discharge envelope axis will be directly vertically below the outer envelope axis. The pins themselves can be arranged to constitute locating means for ensuring correct orientation of the lamp, for example by using pins of different sizes for each pair, fitting into holes of corresponding different sizes in each lampholder; alternatively, if desired, an additional locating pin may be attached to each cap, and arranged to co-operate with an additional hole in each lampholder.

An additional advantage of an outer envelope of the double ended form is that the presence of any metal members running substantially parallel to the discharge path, in the space between the discharge envelope and the outer envelope wall, can be avoided. Thus in a double ended lamp, not only is the lead to each electrode sealed through the adjacent end of the outer envelope, but also the discharge envelope can be mounted within the outer envelope by means of metal wire and/or strip arrangements sealed into the respective ends of the outer envelope and each supporting the adjacent end of the discharge envelope, such support means if desired consisting of or including the said leads: the use of a discharge envelope mounting arrangement of the type employed in a conventional single ended lamp, com-

prising a substantially rectangular stout wire frame the long sides of which run substantially parallel to the discharge envelope axis, and which constitutes the lead to the electrode located in the end of the discharge envelope remote from the capped end of the outer envelope, is thus eliminated. The elimination of such metal members lying parallel to the discharge path is especially advantageous in the case of a lamp of the type specified having a filling which includes a sodium halide, since it results in a reduction in the loss of sodium ions from the filling by diffusion through the discharge envelope wall, which diffusion is believed to be largely caused by attraction of the sodium ions by electrons present as a result of photoelectric emission from the wire frame, in a single ended lamp as aforesaid.

The discharge envelope of a lamp of the invention is suitably formed of fused silica and may be of conventional construction, with a molybdenum foil pinch seal closing each end of the envelope, and an electrode, suitably in the form of a coil of tungsten wire, or of any other desired form and with or without an activator, welded to the strip of molybdenum foil within each pinch and extending into the envelope. If metal halides are included in the filling of the discharge envelope, the molybdenum foil strips may, if desired, be coated with tungsten as described in the specification of co-pending Patent Application No. 46698/75 (Serial No. 1,521,129) as a safeguard against deterioration of the seals resulting from attack by the halides in either condensed or vapour form, in operation of the lamp.

If desired, the electrodes may be so shaped or so located that their inner ends are removed from the longitudinal axis of the discharge envelope, so that when the lamp is mounted in the correct horizontal operating position, the horizontal discharge path between the electrodes lies parallel to and below the longitudinal axis of the discharge envelope; this arrangement enhances the effect of the positioning of the discharge envelope below the horizontal axis of the outer envelope, in promoting improved uniformity of temperature distribution between different parts of the discharge envelope in operation. For example, the electrodes may be sealed into the respective pinches at locations offset from the centres of the pinches, or the electrodes may be of the form described in the specification of co-pending Patent Application No. 46699/75 (Serial No. 1,522,036), consisting of outer, central and inner sections with the central section inclined so that the inner section, or at least the inner end thereof, is located between the axis and the wall of the discharge envelope.

The outer envelope may, if desired, contain a filling of inert gas, for example nitrogen, at sub-atmospheric pressure. Such a filling may not adversely affect the luminous efficacy of the lamp and is advantageous in some cases, for example assisting in reducing the loss of sodium ions from the discharge envelope in cases where the filling of the latter includes a sodium halide. Further if desired, the interior surface of the outer envelope wall may be wholly or partially coated with an infra-red reflecting light-transmissive film, for example of suitably doped tin oxide or indium oxide, to raise the overall temperature attained by the discharge envelope in operation of the lamp, and to assist in reducing differences in temperature between different parts of the discharge envelope.

A specific embodiment of a lamp in accordance with the invention will now be described by way of example with reference to the drawing accompanying the Provisional Specification, in which

Figure 1 shows the lamp in side elevation in the horizontal operating position, and

Figure 2 is a plan view of the lamp shown in Figure 1. Like parts in the two figures of the drawing are indicated by the same reference numerals.

The lamp shown in the drawing comprises a tubular fused silica discharge envelope 1 mounted within a double ended cylindrical borosilicate glass outer envelope 2 of constant circular cross-section, in such a manner that the longitudinal axis of the discharge envelope lies vertically below that of the outer envelope when the lamp is in the correct operating position, as shown. The outer envelope 2 is closed at each end by means of a pinched foot tube 3, sealed into the end of the envelope tube, and a bipin cap 4, the pair of pins 5, 6 on each cap being aligned orthogonallly to the plane containing the longitudinal axes of both the outer envelope and the discharge envelope.

The discharge envelope 1 contains a filling of mercury, rare gas, and one or more metal halides, and is closed at each end by a pinch 7 into which is sealed an assembly consisting of a molybdenum foil strip 8, a tungsten wire single coil electrode 9 which is welded to the inner end of the molybdenum foil, and a short length of molybdenum wire 10 which is welded to the outer end of the molybdenum foil and extends to the exterior of the pinch. The external end of each wire 10 is welded to the inner end of a nickel strip 11, the outer end of which is welded to a stout molybdenum wire 12 which is bent as shown and is sealed through the adjacent foot tube 3 and connected to the pin 5 on the adjacent cap. The assemblies of wire 12, nickel strip 11, wire 10 and molybdenum foil 8 thus constitute both conducting leads from the terminal pins

5 to the respective electrodes 9, and the means for supporting the discharge envelope 1 in the desired position within the outer envelope 2. The lengths of nickel strip 11 include bent portions 13 to enable thermal expansion of the lead assembly at the operating temperature of the lamp to be accommodated. Nickel rings 14, for supporting getter material in known manner, are carried by additional molybdenum wires 15 which are sealed into the respective foot tubes.

In a specific example of a lamp of the form described above with reference to the drawing, the outer envelope 2, is 19 cm long and has an internal diameter of 38 mm, and contains a filling of nitrogen at a pressure of 200 torr at room temperature. The internal and external diameters of the discharge envelope 1 are respectively 10 mm and 12 mm, the length of the discharge path between the electrodes 9 is 26 mm, and this envelope contains a filling consisting of 25 mg mercury, 15 mg sodium halide, 5 mg scandium iodide and xenon or argon at a room temperature pressure of 20 torr. The discharge envelope is so positioned in the outer envelope that the distance between the outer surface of the lowermost part of the discharge envelope wall and the adjacent part of the inner surface of the outer envelope wall, when the lamp is in the operating position as shown in Figure 1, is 3 mm: hence the vertical distance between the longitudinal axes of the discharge envelope and the outer envelope is 10 mm. In normal operation this lamp dissipates 175 watts at a tube voltage of 120 volts, and has a luminous efficacy of 88 lumens per watt. We have found that if the lamp of the example is operated with incorrect orientation, such that the longitudinal axis of the discharge envelope is vertically above that of the outer envelope, the luminous efficacy of the lamp is reduced by about 3%.

WHAT WE CLAIM IS:—

1. A high pressure electric discharge lamp of the type specified, wherein the outer envelope is of constant cross-section elongate cylindrical form and the discharge envelope is mounted within the outer envelope with its longitudinal axis parallel to the longitudinal axis of the outer envelope but displaced therefrom, the lamp in use being operated with both of the said axes disposed horizontally and with the said axis of the discharge envelope substantially vertically below (as hereinbefore defined) the said axis of the outer envelope.

2. A lamp according to Claim 1, wherein the outer envelope is of circular cross-section, the external diameter of the discharge envelope is approximately one third of the internal diameter of the outer envelope, and the discharge envelope is so positioned within the outer envelope that the distance between the most closely adjacent parts of the walls of the discharge envelope and the outer envelope is approximately one twelfth of the internal diameter of the outer envelope but is not less than three millimeters.

3. A lamp according to Claim 1 or 2, which is of double ended form, wherein the lead to each of the electrodes included within the discharge envelope is sealed through the end of the outer envelope adjacent to that electrode and each end of the outer envelope is fitted with a cap designed to be inserted into a lampholder and incorporating a terminal to which the lead sealed through that end is connected.

4. A lamp according to Claim 3, wherein each end of the outer envelope is fitted with a bipin cap, one pin on each cap constituting a said terminal.

5. A lamp according to any preceding Claim wherein the electrodes are so shaped or so located within the discharge envelope that their inner ends are removed from the longitudinal axis of the discharge envelope, so that the horizontal discharge path between the electrodes lies parallel to the said axis.

6. A high pressure electric discharge lamp according to Claim 1, substantially as shown in, and as hereinbefore described with reference to, the drawing accompanying the Provisional Specification.

7. An arrangement including a lamp according to any preceding Claim and a lampholder or pair of lampholders in which the lamp is mounted for operation, wherein the lamp is mounted in such a position that the discharge envelope is disposed with its longitudinal axis lying horizontally, and the lamp is so oriented that the said axis of the discharge envelope lies substantially vertically below (as hereinbefore defined) the longitudinal axis of the outer envelope.

8. An arrangement according to Claim 7, wherein locating means are carried on, or included in the construction of, the cap or caps fitted over one or both ends of the outer envelope, and are arranged to cooperate with means provided in the lampholder or lampholders.

9. An arrangement according to Claim 7 or 8, wherein the lamp electrodes are so shaped or so located within the discharge envelope that the horizontal discharge path between the electrodes lies parallel to and below the longitudinal axis of the discharge envelope.

For the Applicants:
J. E. M. HOLLAND,
Chartered Patent Agent.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1562929 PROVISIONAL SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale

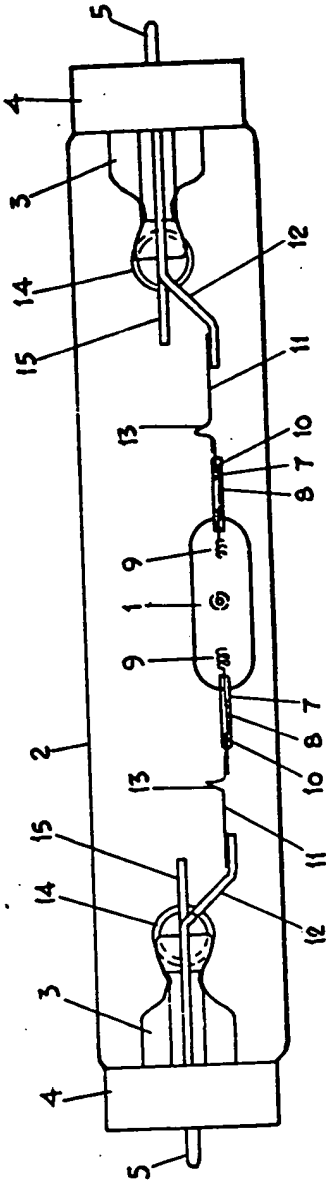

FIG.1.

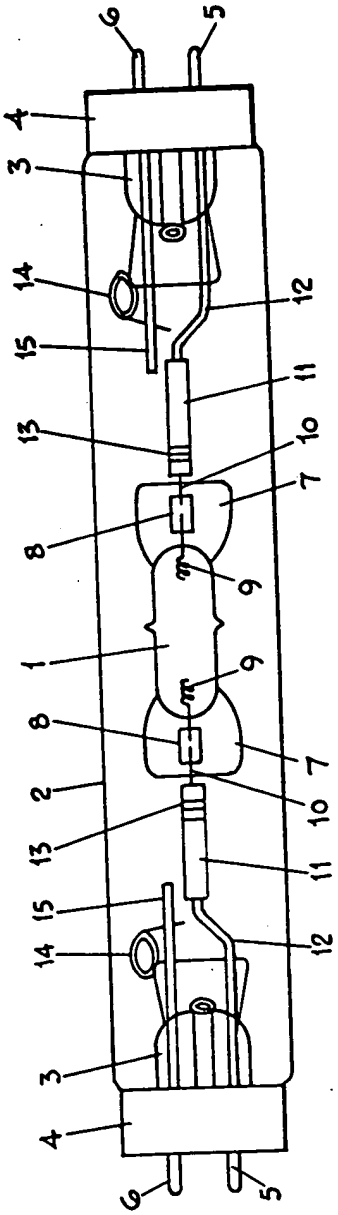

FIG.2.